# EXPLORING THE CONTEXT OF PRICE QUOTATION ON DESIGN PROJECTS

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**Abstract:** Information about the process of price quotation in design projects was collected through in-depth interviews with experts in the field and a survey of design professionals. Content analysis was applied to the transcripts of 13 interviews and revealed four dimensions whose inclusion in the process adds robustness to time estimates during the process of price quotation on design projects. The correlations among these dimensions were evaluated through the application of a survey that resulted in 427 valid responses. The results indicated that the entire professional community reinforced the need to observe them to ensure greater assertiveness in the studied processes.

## 1. INTRODUCTION

Estimation of the time needed to complete the tasks of a project has been addressed by researchers for some time (Abdel-Hamid and Madnick, 1986) and is considered a complex process in the various segments of project development. However, the manner in which the process is performed can have a significant impact on the decision-making process, in particular, in the field of design (Little, 1987). Despite the efforts already undertaken, the topic continues to be explored by various authors (Li et al., 2015). For example, Mousavi et al. (2013) attempt to define an algorithm for time estimation in the development of new projects. Kim et al. (2008) propose time estimates for tasks performed on workstations of multiple products. Bashir and Thomson (2001a) have developed a model for estimation based on analogies. McCulla (1989) discusses the process of evaluating estimates on projects.

One characteristic that these studies share is that in general, they seek to estimate the duration of project activities in a deterministic manner, but they have been demonstrated to be largely inaccurate (Mortaji et al., 2015). These studies also corroborate the complexity and difficulty of producing time estimates in the development of projects. Among the factors that account for this complexity, one can observe the non-linearity of the process and the limited availability of data patterns (Mousavi et al., 2013). Kim et al. (2008) note that the process is made more difficult by the need to allocate time manually because this allocation requires intimate knowledge of the tasks. McCulla (1989) observes that the difficulty arises from the existence of several lifecycle models, from the fact that a project's tasks may be unique and, finally, from a lack of available historical data. These difficulties pose an obstacle to the price quotation process, which depends on the ability of professionals in the field to foresee circumstances (Canadian Construction Association, 2012; Chen et al., 2016). This dependence arises from the need to make decisions based on preliminary information (Morog, 2003), when the scope of the project is not yet settled. This challenge is even more relevant when one considers that companies must respond quickly to requests for quotes because this may give them an edge over their competitors (Canadian Construction Association, 2012; Serrat et al., 2013) and thus determine their profitability (Salam et al., 2009). To develop reliable price quotes, companies need to work with forecasts that are accurate (Caron et al., 2016) and well understood (Elragal and Haddara, 2010; Pahl and Beitz, 2007), guided by the team's knowledge of the type of activities to be undertaken. For design projects, however, there is a gap in the data needed to make reliable time estimates (Bashir and Thomson, 2001b).

To explore this gap, the present study began by conducting in-depth interviews with professionals in the field of design. This was followed by systematic content analysis (Bardin, 2000), which resulted in the identification of four dimensions considered necessary for the development of a structured process for price quotation on design projects.

Finally, the dimensions were evaluated via a survey that sought to understand perceptions of their relevance.

The research presented in this article contributes to the understanding of the environment in which project quotes are developed and presents dimensions that make the process of quoting prices more reliable. The dimensions are presented together with their relationships to both time estimates and price quotes for design projects. Finally, the article presents a set of statistical analyses that support recognition of the dimensions Knowledge, Planning and Control, Implementation, and Methods as important for increasing the robustness of time estimates in price quotation on design projects.

## 2. Theoretical basis

Of great importance and closely related to the determination of project costs (Hellenbrand et al., 2010), estimation of the number of man-hours needed to perform activities (Salam and Bhuiyan, 2016) is a complex task worthy of researchers' attention (Elragal and Haddara, 2010; Pahl and Beitz, 2007) because it depends on, among other factors, the individual's experience with the activities that the project entails (Salam and Bhuiyan, 2016). Additionally, time is one of the important indicators to be observed in project delivery to ensure the project's profitability (Wynn and Clarkson, 2009).

Consistent with the above, in their discussion of the design effort involved in project revisions, Hölttä and Otto (2005) showed that many factors impact time estimates, among the most important being the degree of experience and familiarity with the activity. (Salam and Bhuiyan, 2016) explain that in the field of design, an individual with several years of work experience can be expected to complete an activity more rapidly than others with little experience.

This fact is relevant because according to Hellenbrand et al. (2010), the cost of project development depends on the number of hours of effort dedicated to it by the designer, as they consider the designer's time to be the only resource applied to the development process. This dependence results in the development costs being closely tied to the development effort, measured in terms of time (Hellenbrand et al., 2010). However, the authors mention that time estimates in the process are problematic because the activities are not independent of each other, thus making it difficult to specify the amount of time dedicated to each task. This problem leads to the conclusion that during the development process, the designer cannot estimate the cost of each task accurately (Hellenbrand et al., 2010), thus making the process significantly more complex.

Within this complex context, Salam and Bhuiyan (2016) indicate that the ability to estimate and fully understand the design effort is crucial for determining a project's final cost. Many studies have been developed to examine cost estimates (Anbari, 2004; Cioffi, 2006; Lipke et al., 2009; Vanhoucke and Vandevoorde, 2005), and invariably, they address this item as part of the product development, even if it is during its early stages. Regardless of the size and duration of a project, there are three main goals to be achieved regarding the specifications: time, cost and performance (Mortaji et al., 2015), and maintaining the balance. Managing competing demands among these three goals is one of the main challenges faced by project managers (Larson and Gray, 2011).

Estimation is defined as "an approximate calculation or judgement of the value, number, quantity, or extent of something" (Oxford Dictionary, 2003). In the course of developing a project, estimations are necessary for price quotation, planning and executing the project.

According to the PMBOK Guide, time estimation is the process of estimating the total number of work periods required to complete individual activities, based on an estimate of resources (Project Management Institute, 2013). Without an accurate estimate, it is difficult to make timely decisions that may provide a competitive advantage to the organization (Tyagi et al., 2015). Serrat et al. (2013) add that in a competitive market environment, timely delivery of appropriate quotes to potential clients can put a company ahead of its competitors.

For designers, time estimation poses a challenge, first of all because the reference data available in other fields is not easily accessible in the design field. In addition, the fact that design projects are very likely to be unique (Kumar, 2008; Rittel and Webber, 1973) reinforces this difficulty.

In general, time estimation has been considered to present challenge to management for some time. (Bashir and Thomson, 2001a) report a perceived need for a better estimation process, since it is increasingly important to deliver products on time and within budget. They base this perception on the assessment that in field of design, costs overruns are due to the poor quality of estimates (Bashir and Thomson, 2001b). The authors add that the search for solutions to this problem is even more urgent when one considers that the lifecycles of products are ever shorter (Bashir and Thomson, 2001b). These authors emphasize that estimates of the design effort have received little attention from scholars, and few models have been proposed or submitted for testing. Most of the existing models are very specific and lack potential for widespread application (Bashir and Thomson, 2001b).

Corroborating researchers' frequent suggestion that inaccurate estimations of effort are one of the main contributors to project failure, Verner et al. (2007) emphasize that lack of time causes more project failures than all other possible causes combined. The authors also express the opinion that the problem with estimates persists, despite the research performed on this subject. Sharing the same view, in their quest to make projects more successful through more accurate estimates, Chou and Wu (2013) claim that despite significant progress in defining procedures for managing estimates, managers still face problems related to subjective opinions and guesses. These practices invariably result in inaccurate estimates, (Chou and Wu, 2013) which place the whole development process at risk.

Agreeing with this view and addressing the complexity of estimating effort in the early stages of the development cycle, such as preparing quotes, Mousavi et al. (2013) attribute this condition to the non-linearity of development and limited availability of data patterns. The authors emphasize the importance of estimates, especially when market pressure, the rapid introduction of new products and significantly shorter development cycles require a quick response (Mousavi et al., 2013). Problems with time estimation may be due to a lack of understanding of the effort needed to perform design activities (Hellenbrand et al., 2010). According to Hellenbrand et al. (2010), the cost of developing a project is closely tied to the number of hours spent by the designer because the designer is the only resource employed during the early stages of a product's development (Hellenbrand et al., 2010). Therefore, it is necessary to know how much effort is needed to perform each task in the activity to prepare a quote. Under these circumstances, Browning (1998) believes that the process of price quotation is of no use and argues that designers are unable to estimate accurately the times required for each activity separately.

Based on the analysis of the views described above, it may be noted that the estimation of time in project development is understood as an important, relevant and highly complex process. It is also noted that such understandings imply that some factors are important to the effectiveness of the process. In this study, these factors will be termed Dimension of Time Estimation.

These considerations lead to the following hypothesis: **Hypothesis 1** – TIME ESTIMATION is closely related to the preparation of a PRICE QUOTATION for a design project.

## 3. Methodology

This study was performed in the following two distinct phases, both of which involved professionals in the design field:

**(1)** qualitative research using semi-structured in-depth interviews with experts to understand the dynamics of preparing quotes in the field of design and identify the structural elements of the process;

**(2)** qualitative-quantitative research using a survey of design professionals throughout Brazil to determine whether these dimensions correspond to the processes of time estimation and price quotation. The survey also sought to assess whether there are correlations among the elements of the price quotation process in the design field.

### 3.1 Participants

Thirteen design professionals active in various segments were invited to participate, as indicated in **Table 1**. These professionals were selected randomly through spontaneous acceptance of an invitation sent by the researcher to professionals listed in a catalogue of local design professionals. The criteria used for participant selection were a) academic training in design and b) active participation in the development of design projects. These criteria ensured that all the professionals were involved with design practice on a daily basis, which was relevant to the study.

Initially, 1,900 designers were chosen for participation in the survey from a published catalogue of professionals in the field. As the number of responses was not satisfactory, an additional 970 professionals were contacted through professional networks, and the response rate was 18.15% in this case.

For both stages of the study, the sample was defined by convenience, as only those who were willing to participate were interviewed or surveyed.

### 3.2 Data collection

Data collection was also performed in two stages, as described below.

#### 3.2.1 Interviews

The interview process consisted of identifying professionals, preparing and delivering the invitations, developing the protocol of primary and follow-up questions, conducting interviews, transcribing the interviews, analyzing data and collecting materials. The interviews addressed the topic of project design, exploring how the designer performs this activity in the course of daily work.

The interviews began with a context developed by the researcher, followed by the main question, "how does a designer develop a quote for a design project?" The professionals were free to approach the subject from their own perspective, and, if necessary, the researcher intervened to redirect the conversation in a manner that addressed the secondary questions to cover the entire scope desired. Thirteen interviews were conducted over 45 days.

#### 3.2.2 Survey

Thirteen hypotheses were created to guide the survey. They addressed the dimensions that were identified during the interview stage (D1, D2, D3 and D4), the estimation of time and the process of price quotation on design projects. The hypotheses were divided into two groups, with nine (H1-H9) classified as primary; the primary hypotheses relate the dimensions to the processes of time estimation and price quotation. The four remaining hypotheses, H10-H13, were classified as secondary and evaluate correlations among the four dimensions. **Figure 1** shows the hypotheses developed to test the relationship between the elements of the price quotation process for design projects. The questionnaire consisted of 60 questions divided between a) defining the respondent's profile, (b) describing professional performance and c) testing the hypotheses.

First, the questionnaires were distributed via the Internet using an e-mail marketing program such that they would not be classified as spam. This strategy was continued for approximately 30 days but did not receive significant response, despite weekly repetitions of the invitation. The response rate during this time period was 0.7%. Taking an alternative strategy in the search for a better response rate, it was decided to add professionals who were contacted through a professional network. These professionals were invited to join the professional networks of the researchers, and when they accepted, they were invited to participate in the study. With this strategy, the response rate increased to 18.15%, considering only the professionals who were reached through the professional network. By the end, the overall rate of valid responses reached 14.98%. The entire process of the survey covered a period of 6 months, from the initial preparation of the questionnaire to the collection of the last response. A total of 427 valid responses were obtained.

### 3.3 Data analysis

The process of analysis was performed in the following stages: (a) the interviews were transcribed, (b) content analysis (Bardin, 2000) was employed to identify categories of words cited by respondents, (c) these words were classified according to the context in which they appeared, (d) structural elements of the price quotation process were identified, and finally, (e) the survey results were analyzed.

### 3.4 Data validation

To make inferences from the data, an attempt was made to validate the data by using different sources of information (Bardin, 2000), by cross-referencing the data through analysis of the theoretical framework and by carefully choosing the participants in the various stages of data collection (Bruce et al., 1999).

## 4 Results and discussion

### 4.1 Results of the interviews

Thirteen designers accepted the researcher's invitation to participate in the interviews. The designers' experience in the field ranged from six to 34 years, with a mean of 14.6 years of professional activity.

The interviews totaled 12.5 hours of recording and 94 pages of transcripts, constituting a collection of information about the process of quoting prices for projects involving design products and/or services.

Based on this material and suggestions made by the participants, the following observations regarding aspects of the design process were outlined. Through content analysis (Bardin, 2000), four dimensions were

| Index | Main area of design work | Years of professional training | Years of work experience |
|---|---|---|---|
| 1 | Graphic & digital design | 7 years | 10 years |
| 2 | Product design | 3 years | 6 years |
| 3 | Digital & 3-D design | 7 years | 14 years |
| 4 | Product design | 4 years | 15 years |
| 5 | Editorial & graphic design | 11 years | 27 years |
| 6 | Product design | 17 years | 20 years |
| 7 | Product design | 3 years | 11 years |
| 8 | Product design | 6 years | 6 years |
| 9 | Product design | 10 years | 13 years |
| 10 | Product and graphic design | 17 years | 34 years |
| 11 | Product, graphic and editorial design | 6 years | 9 years |
| 12 | Product design | 10 years | 15 years |
| 13 | Graphic design | 10 years | 10 years |

Table 1. Description of Interview Participants.

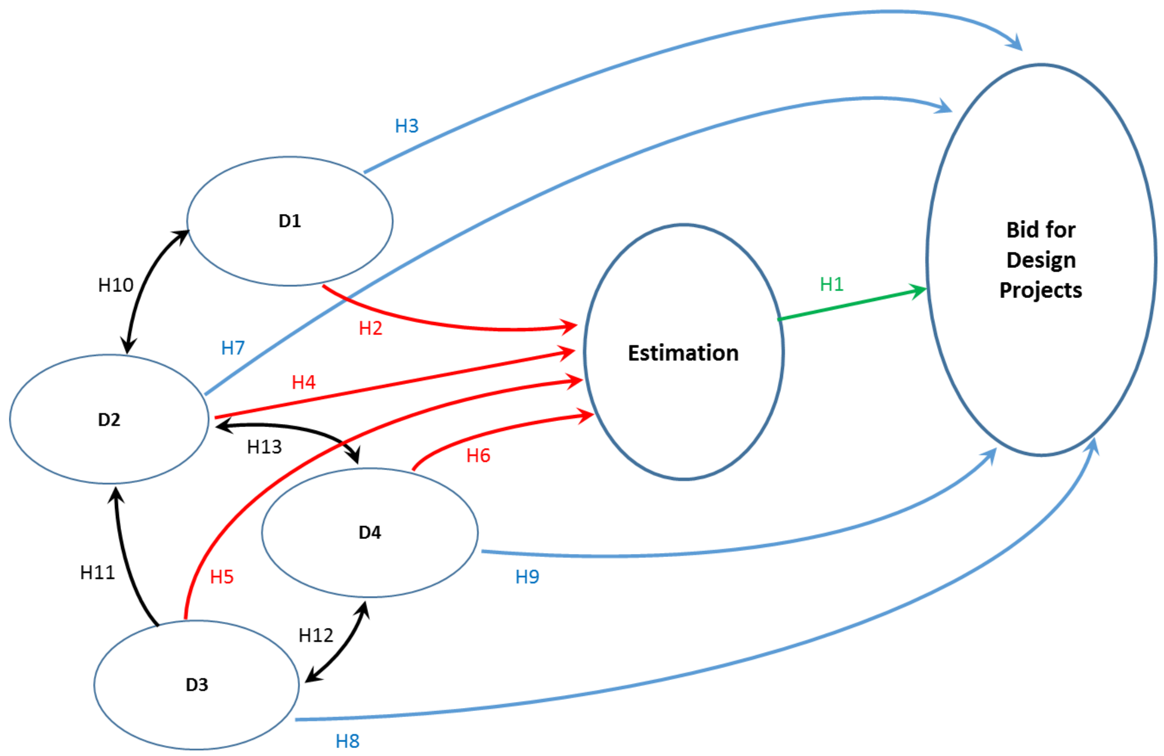


Figure 1. Hypotheses.

identified as being important to the development of a quote for a design project: D1 - Knowledge, D2 - Execution, D3 - Design Method and D4 - Planning and Control.

The thesis this study seeks to prove is that these dimensions play important roles in strengthening the process of price quotation on design projects. As observed in Figure 1, all four dimensions are primarily related to the processes of Estimation and Price Quotation on Design Projects. Also on the same level of relationship, one can note the relationship between the process of Estimation and the process of Price Quotation on Design Projects. Finally, the hypotheses that test the inter-relationship among the four dimensions are verified.

#### 4.1.1 D1 – Knowledge

The KNOWLEDGE dimension addresses the set of information necessary to develop a process of estimation and price quotation on a project. Knowledge includes mastery of the content needed to perform the activities of a design professional. Knowledge was subdivided into two distinct approaches: Explicit Knowledge and Tacit Knowledge, following the approach taken by Caron et al. (2016). Explicit knowledge focused on academic education, which in the group interviewed took the form of an average of 8.5 years of professional training. Tacit knowledge was characterized and enriched by the professionals' vast experience and exposure to the labor market, which, as already mentioned, ranged from six to 34 years, with an average of 14.6 years.

According to Kahneman and Tversky (1977), the main causes of failure in project planning are associated with taking an approach to time estimation that draws on limited sources of knowledge rather than seeking an approach that integrates various sources of knowledge, as described by Caron et al. (2016). Traditionally, projects are based on limited sources of knowledge, and the resulting estimate often diverges from reality (Flyvbjerg, 2009).

These considerations lead to the following hypotheses:

**Hypothesis 2** - KNOWLEDGE of the various design activities improves the ESTIMATION of time needed to execute each stage.

**Hypothesis 3** - KNOWLEDGE of design activities is necessary for the process of PRICE QUOTATION on projects in this field.

#### 4.1.2 D2 – Execution

Respondents identified the degree of mastery of the EXECUTION dimension as having a direct impact on the results obtained, saying that this was derived directly from the professional's level of knowledge, especially from the tacit knowledge acquired through long exposure to the subject. Execution is not related only to how or how not to do something. "Execution is a specific set of behaviors and techniques that organizations must master to have a competitive advantage" (Bossidy and Charan, 2002, p.7). One important point to recall about execution is that a thought has no effect unless it is transformed into something that adds value, that is, unless it can be translated into concrete stages of actions (Bossidy and Charan, 2002, p.19). It is these actions that put the actor into direct contact with the details of the activities and build his or her repertoire of experience.

These considerations lead to the following hypotheses:

**Hypothesis 4** - The history of EXECUTION of design projects influences the ESTIMATION of time for new projects.

**Hypothesis 7** - The history of EXECUTION of design projects influences PRICE QUOTATION on new projects.

#### 4.1.3 D3 – Design method

The use of design methods has been described as relevant and important to the robustness of the process for developing new products (Araujo et al., 1996; Nijssen and Lieshout, 1995; Pozatti, 2015). The academic literature has also described the potential benefits of using methods associated with the "Design Thinking" approach to develop innovations (Seidel and Fixson, 2013). The development of innovative methods has been considered crucial for improving the process in response to the need for a more systematic approach to addressing the complexity, risk and cost of designing a project (Cross, 2008, p.45). Although the designers treated this dimension as being purely academic in nature, its value was observed in ensuring that value was added to the process, although, in practice, the activities are usually performed without consideration of their formal organization into stages. The professionals interviewed unanimously agreed that the adoption of a method was important to the execution of projects, even when it did not involve the formal application of methods strictly defined by academia. It was observed that designers require a good understanding of the development method employed by that sector of the market because a lack of such an understanding could result in inaccurate estimations of the time needed for the development.

These considerations lead to the following hypotheses:

**Hypothesis 5** - Mastery of DESIGN METHODS is necessary for accurate ESTIMATION of the time needed to execute different stages in the various design activities.

**Hypothesis 8** - Mastery of DESIGN METHODS positively affects the process of PRICE QUOTATION on projects in this field.

#### 4.1.4 D4 – Planning and control

Planning is a key activity for any organization (Adair, 2013, p.29; Cleland and Gareis, 2006, pp.5-13; Lester, 2003, p.42) and an element needed to respond to technological and market changes (Corfield, 1984). Planning and control are two activities that, if neglected, add a degree of empiricism to the price quotation process. Planning is closely tied to time estimation, begins in the early stages of development and extends throughout the product cycle, during which effective decisions must be made (Hogarth and Makridakis, 1981). Although the importance of planning and its contribution to accurate time estimation and the price quotation process are recognized, designers report that insufficient attention has been given to the application of formal methods for this purpose. It was observed during the interviews that the designer's primary focus is on performance and productivity, without a formal methodology for planning and control, which are mere attempts, usually frustrated ones. Planning and control put the actor in contact with the details of activities to be performed and contribute to the development of a repertoire of experience. They most likely also bolster professionals' confidence in their estimation skills (Subramanian and Breslawski, 1995).

These considerations lead to the following hypotheses:

**Hypothesis 6** - The practice of PLANNING and CONTROL contributes to ESTIMATION of times for design activities.

**Hypothesis 9** - The practice of PLANNING and CONTROL contributes to the process of PRICE QUOTATION on design projects.

#### 4.1.5 Complementary hypotheses

As observed in Figure 1, complementing the set of hypotheses about the dimensions associated with the estimation and price quotation processes, an assessment is made of correlations among the four dimensions of design, and these are tested by the following hypotheses:

**Hypothesis 10** - KNOWLEDGE in design is important for the EXECUTION of design projects and is, in turn, improved by the practice of such activities.

**Hypothesis 11** - The adoption of DESIGN METHODS is necessary for the EXECUTION of design projects.

**Hypothesis 12** - The use of DESIGN METHODS facilitates the PLANNING and CONTROL of activities in the development of a design project.

**Hypothesis 13** - The practice of PLANNING and CONTROL facilitates the EXECUTION of design projects.

### 4.2 Survey results

The evaluation of the survey results was performed in three stages:

**a)** evaluation of the hypotheses and definition of the method of analysis;

**b)** evaluation of the hypotheses in terms of the variables of the profiles;

**c)** evaluation of the hypotheses in terms of the variables of characterization of professional performance.

The analyses were performed using descriptive statistics (analysis of absolute and relative frequency), cross-checking and tests of association between variables using the chi-square test, owing to the categorical nature of the variables examined. The details of each step are presented below.

#### 4.2.1 Evaluation of the hypotheses and definition of the method of analysis

To evaluate the hypotheses presented above, a set with 13 null hypotheses was created, as described in **Table 2**. These hypotheses were evaluated via the questionnaire-based survey. The digit 0 was added to the null hypotheses to differentiate them from their corresponding hypotheses. The questions were formulated using a Likert-type scale of assessment for

| Index | Hypothesis |
|---|---|
| H01 | Time estimation is an activity that bears no relation to the development of a bid on a design project. |
| H02 | Knowledge of the various design activities bears no relation to estimation of the time needed to carry out its stages. |
| H03 | Knowledge of design activities is unnecessary in the process of bidding on projects in this field. |
| H04 | Experience executing design projects does not affect time estimations for new projects. |
| H05 | Mastery of design methods bears no relation to estimations of the time needed to carry out the stages of various design activities. |
| H06 | The practice of planning and control does not affect the development of time estimations for design activities. |
| H07 | Experience executing design projects does not affect bidding on new projects. |
| H08 | The application of design methods does not affect the process of bidding on projects in this field. |
| H09 | Planning and control do not affect the process of bidding on design projects. |
| H010 | Knowledge in design and execution of design projects are unrelated to each other. |
| H011 | The application of design methods does not affect the execution in the development of design projects. |
| H012 | The use of design methods does not affect planning and control of activities in the development of a design project. |
| H013 | Planning and control and execution of design projects are unrelated to each other. |

Table 2. Set of Null Hypotheses.

| Hypothesis | Responses | Mean | SD | Minimum | 25th percentile | Median | 75th percentile | Maximum |
|---|---|---|---|---|---|---|---|---|
| H01 | 427 | 1.29 | .03 | 1 | 1 | 1 | 1 | 4 |
| H02 | 427 | 1.30 | .03 | 1 | 1 | 1 | 1 | 4 |
| H03 | 427 | 1.29 | .04 | 1 | 1 | 1 | 1 | 4 |
| H04 | 427 | 1.40 | .03 | 1 | 1 | 1 | 2 | 4 |
| H05 | 427 | 1.37 | .03 | 1 | 1 | 1 | 2 | 4 |
| H06 | 427 | 1.29 | .03 | 1 | 1 | 1 | 2 | 4 |
| H07 | 427 | 1.38 | .03 | 1 | 1 | 1 | 2 | 4 |
| H08 | 427 | 1.59 | .04 | 1 | 1 | 1 | 2 | 4 |
| H09 | 427 | 1.41 | .03 | 1 | 1 | 1 | 2 | 4 |
| H010 | 427 | 1.30 | .03 | 1 | 1 | 1 | 1 | 4 |
| H011 | 427 | 1.37 | .03 | 1 | 1 | 1 | 2 | 4 |
| H012 | 427 | 1.47 | .04 | 1 | 1 | 1 | 2 | 4 |
| H013 | 427 | 1.25 | .02 | 1 | 1 | 1 | 1 | 4 |

Table 3. Numerical Statistics of the Hypotheses.





Table 4. Evaluation of the Hypotheses by Category.

| | H01 | | H02 | | H03 | | | |
|---|---|---|---|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent | Frequency | Percent | | |
| Completely disagree | 347 | 81.3 | 326 | 76.3 | 363 | 85.0 | | |
| Partly disagree | 48 | 11.2 | 80 | 18.7 | 28 | 6.6 | | |
| Partly agree | 21 | 4.9 | 13 | 3.0 | 11 | 2.6 | | |
| Completely agree | 11 | 2.6 | 8 | 1.9 | 25 | 5.9 | | |
| | | | | | | | | |
| | H04 | | H05 | | H06 | | | |
| | Frequency | Percent | Frequency | Percent | Frequency | Percent | | |
| Completely disagree | 295 | 69.1 | 304 | 71.2 | 315 | 73.8 | | |
| Partly disagree | 103 | 24.1 | 93 | 21.8 | 101 | 23.7 | | |
| Partly agree | 21 | 4.9 | 24 | 5.6 | 9 | 2.1 | | |
| Completely agree | 8 | 1.9 | 6 | 1.4 | 2 | 0.5 | | |
| | | | | | | | | |
| | H07 | | H08 | | H09 | | | |
| | Frequency | Percent | Frequency | Percent | Frequency | Percent | | |
| Completely disagree | 294 | 68.9 | 238 | 55.7 | 291 | 68.1 | | |
| Partly disagree | 108 | 25.3 | 137 | 32.1 | 103 | 24.1 | | |
| Partly agree | 20 | 4.7 | 40 | 9.4 | 25 | 5.9 | | |
| Completely agree | 5 | 1.2 | 12 | 2.8 | 8 | 1.9 | | |
| | | | | | | | | |
| | H010 | | H011 | | H012 | | H013 | |
| | Frequency | Percent | Frequency | Percent | Frequency | Percent | Frequency | Percent |
| Completely disagree | 328 | 76.8 | 302 | 70.7 | 281 | 65.8 | 332 | 77.8 |
| Partly disagree | 74 | 17.3 | 96 | 22.5 | 103 | 24.1 | 84 | 19.7 |
| Partly agree | 20 | 4.7 | 24 | 5.6 | 33 | 7.7 | 10 | 2.3 |
| Completely agree | 5 | 1.2 | 5 | 1.2 | 10 | 2.3 | 1 | 0.2 |

Table 5. Profile Variables.

| Variable | Description | Options | | | | |
|---|---|---|---|---|---|---|
| V1 | Gender | Male | Female | | | |
| | | 60.7% | 39.3% | | | |
| V2 | Age | 18 – 24 years | 25 – 29 years | 30 – 44 years | 45 – 54 years | 55 or older |
| | | 5.2% | 24.4% | 57.4% | 10.1% | 3.0% |
| V3 | Time since completion of professional training | Fewer than 5 years | 5 – 9 years | 10 – 14 years | 15 or older | |
| | | 25.3% | 28.3% | 20.6% | 25.8% | |
| V4 | Time working in the development of design projects | Fewer than 5 years | 5 – 9 years | 10 – 14 years | 15 or older | |
| | | 17.1% | 32.6% | 26.0% | 24.4% | |
| V5 | How many design projects have you developed in your area? | Fewer than 10 projects | 10 – 29 projects | 30 – 49 projects | 50 projects or more | |
| | | 10.1% | 25.3% | 8.2% | 56.4% | |

the answers, with the following degrees of agreement: 1 for "totally disagree," 2 for "partly disagree," 3 for "partly agree" and 4 for "totally agree."

Four response options were used to force the respondent to take a position regarding the question posed, either rejecting or accepting the hypothesis presented. Thus, the intermediate response "neither agree nor disagree" was excluded.

The evaluation initially aimed to identify the behavior of the variables with respect to their distribution among the categories, that is, to determine whether the variables obeyed a normal distribution. Understanding this is important to determine which statistical tests of comparison should be applied to compare one variable with another. In this case, the variables related to profile and professional performance were compared.

The Kolmogorov-Smirnov test for a sample with a significance level of 0.05 revealed statistically significant results for all variables, indicating that to be studied numerically, these variables would need to be analyzed using nonparametric tests and comparison of medians/quartiles because do not obey a normal distribution. In light of this situation, **Table 3** presents the statistical evaluation of the questions that address the hypotheses, evaluated numerically, according to their degree of agreement.

Observing the nonparametric measures of variables presented in **Table 3** (median and percentiles), the homogeneity of the responses is notable, with little variation, as the medians and percentiles are similar in all cases.

In light of these results, it was decided to evaluate the behavior of the variables and cross-check them with other variables related to profiles and the characterization of professional activity, analyzing them by category and comparing the answers between groups using the chi-square test.

**Table 4** presents the evaluation by category, showing that all the null hypotheses were refuted, with "partly disagree" and "completely disagree" responses accounting for more than 90% of the responses in most cases. This result indicates a high degree of agreement among the respondents that the dimensions Knowledge, Execution, Method and Planning and Control are important for the estimation of time and, therefore, the process of price quotation on design activities.

Hypothesis 1, which relates time estimation to the development of design quotes, was evaluated positively by 92.5% of the respondents, leaving no doubt about the importance of this activity in the price quotation process and confirming the observations of Hellenbrand et al. (2010). Hypothesis 2, which relates knowledge of design activities to the process of time estimation, received even greater validation of 95.0%, corroborating the conclusion of Caron et al. (2016) that knowledge is necessary for the correct performance of processes. This also reinforces the view of Hölttä and Otto (2005) that time is affected by familiarity with the activity to be performed. In the same line of analysis, hypothesis 3, which relates knowledge to the process of price quotation on projects, obtained approval from 91.6% of the respondents.

Hypothesis 4, which relates experience with project execution to the process of time estimation, was approved by 93.2% of the respondents, leaving no doubt about its importance in this regard. Similarly, hypothesis 7, which relates the history of project execution to price quotation on projects, received 94.2% approval. These conditions support the view of Bossidy and Charan (2002) that experience with project execution is a key factor in producing results.

Hypothesis 5, which relates mastery of design methods to time estimation, and hypothesis 8, which posits that the application of methods positively affects the price quotation process, were evaluated positively by 93% and 87.8% of the respondents, respectively. These results corroborate the findings by Nijssen and Lieshout (1995), Araujo et al. (1996) and Pozatti (2015) about design methods' important contribution to strengthening the process of new product development, focusing in this case on the processes of time estimation and price quotation. Recognition of the importance of adopting a method might minimize a weakness noted by Hellenbrand et al. (2010), who remark that the difficulty of distinguishing among the different activities to be performed hampers the designer's ability to estimate the cost of each task.

Hypothesis 6, which addresses the effect of planning and control on time estimation, obtained significant acceptance of 97.5%. Additionally, hypothesis 9, which considers the effect of planning and control on the price quotation process, obtained the approval of 92.2% of the respondents. These perceptions reinforce the correlation observed by Hogarth and Makridakis (1981) and the key role played by planning and control in the processes, as described by Adair (2013), Cleland and Gareis (2006) and Lester (2003).

Hypothesis 10, which relates the dimensions of knowledge and execution, was positively evaluated by 94.1% of the respondents, reinforcing the views expressed by the experts interviewed that execution is derived directly from the professional's level of knowledge, especially tacit knowledge. In this sense, whereas execution depends on knowledge, as mentioned above, it is also strengthened by the practical application of this knowledge.

Hypothesis 11, which addresses how design methods influence execution in the development of projects, was approved by 93.2% of the participants. This result supports Bossidy and Charan (2002) view of execution as a type of method to translate thought into something that adds value, that is, to translate thought into concrete action steps.

Hypothesis 12, which relates the use of design method with planning and control, was evaluated positively by 89.9% of the respondents, thus reinforcing the view expressed the experts interviewed, who held that the adoption of methods usually makes it possible to visualize the project's stages and better plan and control their execution.

Hypothesis 13, which addresses the correlation between planning and control and execution, was evaluated positively by 97.5% of the respondents. This reinforces Bossidy and Charan's (2002) observation that to add value, a thought must be transformable into concrete action, which facilitates planning, in turn favoring execution and control.

The chi-square, Fisher's exact and Monte Carlo tests were used to cross-check the variables of the respondents' professional profiles and professional performance. The test statistics (p-value) and their respective confidence intervals are highlighted in the test tables to make it easier to locate them.

Analyses of the correlations between the control variables and hypotheses are presented below. The degree of significance for these assessments was 0.05. Under these conditions, when the variable being analyzed exhibited a significant p-value, attention was directed to the upper limit of the confidence interval, where the same result was expected.

#### 4.2.2 Evaluation of the hypotheses in terms of the profile variables

The variables used to describe the respondents' profile are listed in **Table 5**, where one can observe a group formed by professionals predominantly between the ages of 30 and 44 years old (57.4%), with years of professional training well distributed among the age groups.

Most members of the group, 83%, have more than five years' experience developing design projects, and a majority, 56%, have significant exposure to the market, having developed more than 50 projects over the course of their careers.

**Table 6** presents the results of crossing the variables in question with the hypotheses, highlighting some cases of statistical significance. Analysis of hypotheses H01, H03, H06, H08, H09, H010, H011, H012 and H013 revealed no statistical significance, as all the participants' responses followed a pattern of rejecting the hypotheses.

In the analysis of hypothesis H02, variable V2, Age, exhibited a statistical significance of 0.023, owing to a different behavior among respondents in the age range of 45 to 54 years old. The sample exhibited a greater concentration of their answers, 88.4%, in the category "completely disagree," unlike other age categories, for which 69% to 77% of the respondents chose this response. Although this behavior represents 10.1% of respondents and therefore was not decisive in rejecting the null hypothesis, it demonstrates that this subgroup of professionals has a greater awareness of the importance of the knowledge dimension for accurate estimation of the time required for design activities.

The results concerning hypothesis H04 reveal a statistically significant relationship between this hypothesis and variable V2, Age. This significance occurred because there was a lower concentration of "completely disagree" answers in the group aged 55 years or older compared with the other groups. This did

| | V1 | | | V2 | | | V3 | | | V4 | | | V5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | |
| | Significance | 95% confidence interval | | Significance | 95% confidence interval | | Significance | 95% confidence interval | | Significance | 95% confidence interval | | Significance | 95% confidence interval | | |
| | | Lower limit | Upper limit | | Lower limit | Upper limit | | Lower limit | Upper limit | | Lower limit | Upper limit | | Lower limit | Upper limit | |
| H01 | 0.156 | 0.149 | 0.163 | 0.118 | 0.112 | 0.124 | 0.885 | 0.878 | 0.891 | 0.104 | 0.098 | 0.110 | 0.158 | 0.151 | 0.165 | |
| H02 | 0.707 | 0.698 | 0.716 | 0,023* | 0.020 | 0.026 | 0.590 | 0.581 | 0.600 | 0.782 | 0.774 | 0.790 | 0.279 | 0.270 | 0.288 | |
| H03 | 0.449 | 0.439 | 0.459 | 0.273 | 0.264 | 0.281 | 0.138 | 0.132 | 0.145 | 0.820 | 0.812 | 0.827 | 0.643 | 0.634 | 0.652 | |
| H04 | 0.990 | 0.988 | 0.992 | 0,017* | 0.014 | 0.019 | 0.908 | 0.902 | 0.913 | 0,04* | 0.036 | 0.043 | 0,000* | 0.000 | 0.000 | |
| H05 | 0.418 | 0.408 | 0.427 | 0.777 | 0.768 | 0.785 | 0.069 | 0.064 | 0.074 | 0.345 | 0.335 | 0.354 | 0,027* | 0.024 | 0.030 | |
| H06 | 0.608 | 0.598 | 0.618 | 0.579 | 0.569 | 0.589 | 0.493 | 0.484 | 0.503 | 0.479 | 0.469 | 0.488 | 0.136 | 0.129 | 0.143 | |
| H07 | 0.760 | 0.751 | 0.768 | 0.396 | 0.386 | 0.405 | 0,018* | 0.015 | 0.020 | 0.047 | 0.043 | 0.051 | 0.351 | 0.342 | 0.360 | |
| H08 | 0.953 | 0.949 | 0.957 | 0.765 | 0.756 | 0.773 | 0.302 | 0.293 | 0.311 | 0.097 | 0.091 | 0.103 | 0.771 | 0.762 | 0.779 | |
| H09 | 0.974 | 0.971 | 0.977 | 0.227 | 0.218 | 0.235 | 0.892 | 0.886 | 0.898 | 0.721 | 0.712 | 0.730 | 0.542 | 0.532 | 0.552 | |
| H010 | 0.057 | 0.052 | 0.061 | 0.486 | 0.476 | 0.495 | 0.484 | 0.474 | 0.493 | 0.439 | 0.429 | 0.449 | 0.477 | 0.467 | 0.487 | |
| H011 | 0.360 | 0.350 | 0.369 | 0.399 | 0.389 | 0.408 | 0.353 | 0.343 | 0.362 | 0.072 | 0.067 | 0.077 | 0.928 | 0.923 | 0.933 | |
| H012 | 0.222 | 0.213 | 0.230 | 0.340 | 0.330 | 0.349 | 0.076 | 0.070 | 0.081 | 0.095 | 0.090 | 0.101 | 0.992 | 0.991 | 0.994 | |
| H013 | 0.724 | 0.715 | 0.732 | 0.359 | 0.349 | 0.368 | 0.962 | 0.958 | 0.966 | 0.107 | 0.101 | 0.113 | 0.402 | 0.393 | 0.412 | |

Table 6. p-value: Hypotheses x Profile.





Table 7. Variables Describing Professional Performance.

| Var | Description | Options | | | | | |
|---|---|---|---|---|---|---|---|
| V6 | How many products have you developed that were patented in your name or in the name of the company with which you worked? | None | 1 – 4 products | 5 – 9 products | 10 – 19 products | 20 or more products | |
| | | 57.8% | 25.1% | 6.3% | 3.3% | 7.5% | |
| V7 | On what percentage of your projects did you correctly estimate the time needed to complete the activities to deliver the design product/services by the deadline? | Under 10% | 10% - 20% | 21% - 40% | 41% - 60% | 61% - 80% | Over 80% |
| | | 2.6% | 6.3% | 11.9% | 22.5% | 33.7% | 23.0% |
| V8 | On average, how many project bids for design products/services do you develop per month? | Up to 4 bids | 5 – 10 bids | 11 – 30 bids | 31 – 60 bids | 61 – 100 bids | More than 100 bids |
| | | 61.8% | 27.2% | 8.7% | 1.4% | 0.5% | 0.5% |
| V9 | On average, how many bids for projects of design products/services do you have accepted per month? | Up to 4 bids | 5 – 10 bids | 11 – 30 bids | 31 – 60 bids | 61 – 100 bids | More than 100 bids |
| | | 82.7% | 11.7% | 4.7% | 0.2% | 0.2% | 0.5% |
| V10 | How much time do you usually have to develop a budget for a bid on design product/services? | Fewer than 5 days | 5 – 10 days | 11 – 15 days | 16 – 20 days | 21 – 30 days | 30 days or more |
| | | 72.1% | 21.1% | 3.3% | 2.1% | 0.0% | 1.4% |

Table 8. p-value: Hypotheses x Description of Professional Performance.

| | V6 | | | V7 | | | V8 | | | V9 | | | V10 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | | Two-sided Monte Carlo statistical significance | | |
| | Significance | 95% confidence interval | | Significance | 95% confidence interval | | Significance Lower limit | Significance | | 95% confidence interval Lower limit | Significance | | 95% confidence interval Upper limit | Significance | |
| | | Lower limit | Upper limit | | Lower limit | Upper limit | | Upper limit | LUpper limit | | Lower limit | Lower limit | | Lower limit | Lower limit |
| H1 | 0.423 | 0.414 | 0.433 | 0.328 | 0.318 | 0.337 | 0.266 | 0.257 | 0.274 | 0.430 | 0.420 | 0.440 | 0.049 | 0.044 | 0.053 |
| H2 | 0.326 | 0.317 | 0.336 | 0.711 | 0.702 | 0.720 | 0.563 | 0.553 | 0.573 | 0.630 | 0.620 | 0.639 | 0.707 | 0.698 | 0.716 |
| H3 | 0.604 | 0.594 | 0.613 | 0.623 | 0.613 | 0.632 | 0.851 | 0.844 | 0.858 | 0.777 | 0.769 | 0.785 | 0.239 | 0.230 | 0.247 |
| H4 | 0.288 | 0.279 | 0.297 | 0.078 | 0.073 | 0.084 | 0.846 | 0.839 | 0.853 | 0.964 | 0.961 | 0.968 | 0.103 | 0.097 | 0.109 |
| H5 | 0.446 | 0.436 | 0.456 | 0.080 | 0.074 | 0.085 | 0.517 | 0.508 | 0.527 | 0.819 | 0.811 | 0.826 | 0.016 | 0.014 | 0.018 |
| H6 | 0.562 | 0.552 | 0.572 | 0.116 | 0.110 | 0.122 | 0.030 | 0.027 | 0.034 | 0.548 | 0.538 | 0.558 | 0.808 | 0.801 | 0.816 |
| H7 | 0.151 | 0.144 | 0.158 | 0.853 | 0.846 | 0.860 | 0.266 | 0.257 | 0.274 | 0.336 | 0.327 | 0.345 | 0.300 | 0.291 | 0.308 |
| H8 | 0.177 | 0.169 | 0.184 | 0.078 | 0.073 | 0.083 | 0.158 | 0.151 | 0.165 | 0.411 | 0.401 | 0.420 | 0.280 | 0.271 | 0.289 |
| H9 | 0.708 | 0.699 | 0.717 | 0.307 | 0.298 | 0.316 | 0.525 | 0.515 | 0.535 | 0.866 | 0.859 | 0.872 | 0.636 | 0.627 | 0.646 |
| H10 | 0.246 | 0.238 | 0.255 | 0.217 | 0.209 | 0.225 | 0.356 | 0.347 | 0.366 | 0.450 | 0.440 | 0.460 | 0.681 | 0.672 | 0.690 |
| H11 | 0.277 | 0.268 | 0.285 | 0.476 | 0.467 | 0.486 | 0.488 | 0.478 | 0.498 | 0.146 | 0.139 | 0.153 | 0.100 | 0.095 | 0.106 |
| H12 | 0.479 | 0.469 | 0.489 | 0.405 | 0.395 | 0.414 | 0.928 | 0.923 | 0.933 | 0.350 | 0.340 | 0.359 | 0.039 | 0.036 | 0.043 |
| H13 | 0.282 | 0.273 | 0.291 | 0.118 | 0.112 | 0.125 | 0.684 | 0.675 | 0.693 | 0.808 | 0.800 | 0.816 | 0.375 | 0.366 | 0.385 |

not, however, significantly affect the final outcome because that group consisted of only 13 professionals, or 3% of the total participants of the study. This condition stands out because the small size of the group means that even a small shift among categories has a disproportionately large impact on the results. The 55 years-and-older age group exhibited a shift from the category "completely disagree" (which accounted for 30.8% of this group's responses, compared to 59.1% and 79.1% for the other groups) to the category "partly agree" (the response given by 23.1% of the members of this age group, compared to 4.5% and 13.5% of the members of other age groups).

It was also noted that variable V4, related to the time the respondent has been active in developing design projects, exhibited a statistically significant correlation with hypothesis H04. Although the null hypothesis was rejected by more than 92% in all groups, this correlation appeared for two reasons. First, there was a slight shift from the category "completely disagree" to "partly disagree" among respondents with fewer than five years' experience, representing 17.1% of the sample. This group exhibited a concentration of 54.8% in the category "completely disagree," compared to 67.6% and 78.8% for the other groups. Second, a shift in the other direction was observed in the group of professionals with 15 or more years of experience. In this group, which makes up 24.4% of the sample but is larger than the preceding group, 78.8% of the respondents said that they "completely disagree," compared with 54.8% and 71.2% of the other groups who gave this answer. Consequently, this group exhibited a lower concentration of "partly disagree" answers, 13.5%, compared with the other groups, of which 23.4% and 38.4% gave this answer.

Finally, there was a statistically significant relationship between hypothesis H04 and variable V5, associated with the number of design projects a professional has developed. For this relationship, the null hypothesis was rejected by more than 83% of the respondents in all groups. It was observed that the significance is based on three factors. First, the group with fewer than 10 executed projects, representing 10.1% of respondents, was more likely than other groups to "partly agree" with the hypothesis: 14.0% of the group chose this answer, whereas 0.9 to 5.7% of the other groups responded "partly agree." Second, the group immediately following the abovementioned group, professionals who had developed 10 to 29 projects, representing 25.3% of the sample, exhibited a shift from the "completely agree" category to the "partly disagree" category, with only 0.9% saying they "completely agree," compared to other groups, of which 5.0% and 14.0% gave that answer. Finally, and most significantly, the group of professionals with 50 or more executed projects, representing 56.4% of the study's participants, shifted from "partly disagree" to "completely disagree," such that only 18.3% chose the former answer, compared to other groups, of which 20 to 34.9% chose "partly disagree." The category of that absorbed the shift revealed that 75.1% of the respondents "completely disagree" with the hypothesis, leading the other groups, of which 48.8% and 68.6% chose "completely disagree."

The statistical significance of the relationship between hypothesis H04 and variable V5 reveals an evolution in the perceived importance of the execution dimension, as the professional gains experience by executing more projects.

An analysis of the relation between variable V5 and hypothesis H05, which addresses the importance of mastery of design method in estimating the time needed to perform design activities, reveals a notable difference in the group of professionals who had performed between 30 and 49 design projects. Members of this group, which represents 8.2% of the respondents, were far more likely than members of other groups to respond "completely agree," with a concentration of 8.6% for this group, compared to 0.0% and 1.9% for the other groups. Because of the small size of the group, this result does not threaten the rejection of the null hypothesis, reinforcing the importance of knowledge of the design method to improving the accuracy of time estimations for activities in this field.

When hypothesis H07, which assesses how experience of executing design projects influences price quotation for new projects, was cross-analyzed with variable V3, which describes how long the respondent has been practicing in this field, a statistically significant relationship was observed for the group of professionals with 5 to 9 years of experience and for the group with more than 15 years of experience. The first group exhibited a 33.9% concentration of "completely disagree" answers, compared with 17.3 and 25.3% in the other groups. In comparison with the other groups, the second group exhibited a shift from "partly disagree" to "completely disagree" responses. The results of both groups were important to the rejection of the null hypothesis because together, they account for 54.1% of the valid responses. These events reinforce the perception that the length of time that an individual has spent in professional practice modifies his or her perception of the variables' value. This behavior was observed in the cases evaluated.

#### 4.3.3 Evaluation of the hypotheses in terms of the variables that describe professional performance

The variables used to describe the respondents' professional performance are presented in **Table 7**. Whereas a majority (51%) of the respondents have no patents registered for the projects they developed, a significant number (25.1%) have up to four registered patents. A total of 89% of the respondents are involved in the preparation of up to 10 budgets monthly, and 93.2% of the professionals have 10 business transactions in the same period.

This group feels pressured by deadlines to submit their proposals because most of them (72.1%) have fewer than five days to develop their budgets and present their proposals. This condition is most likely reflected in the accuracy rate of the times estimated, as between 41 and 80% of the projects are reportedly delivered by the deadline established. However, a significant portion of the respondents (23%) perform reasonably well under pressure and achieve greater precision in their budgets, with up to 80% of the projects being delivered within the time estimated.

**Table 8** presents the results of crossing the variables in question with the hypotheses, highlighting some cases of statistical significance. The analyses of hypotheses H01, H02, H03, H04, H07, H08, H09, H010, H011 and H013 revealed no statistical significance, as all of the participants' responses followed a pattern of rejecting the hypotheses.

The analysis of a potential relationship between H02 and variable V10, which addresses the number of design projects executed, revealed a statistical significance of 0.027, due to the different behavior of respondents who had developed between 30 and 49 projects. Representing a relatively small portion of the sample (8.2%), this group had a concentration of 8.6% of responses in the category "completely agree," in contrast to the other groups, for which that answer accounted for 0.0% and 1.9% of responses.

The statistical significance of 0.030 for the relationship between hypothesis H06 and variable V8, which addresses the number of project quotes developed per month, is due to two conditions. The first, observed in the group with up to four monthly quotes, representing 61.8% of the respondents, is the shift from "partly agree" to "completely disagree", which stands out from the trend of the other groups' responses. In this group, there was a concentration of "completely disagree" answers, 77.3%, compared to the other groups, for which the fraction ranged from 66.7 to 67.2%. The second consists of a greater concentration of "partly agree" answers, 8.1%, among the group that develops between 11 and 30 quotes monthly, compared to the other groups, for which that answer ranged from 0.0% to 3.4%, with an upper limit of 16.7%.

One last occurrence of statistical significance of the relationship of H012 with variable V10 was found among professionals who report having 11 to 15 days to make their quotes, representing 3.3% of the total respondents. However, given the low concentration of answers in the three groups – 11 to 15 days with 3.3%, 16 to 20 days with 2.1%, and more than 30 days with 1.4% – this result is not relevant to the analysis. The rejection of the null hypothesis in this case was determined by the groups "fewer than 5 days," and "5 to 10 days," with 72.1% and 21.1% of the total valid responses, respectively.

## 5 Conclusions

This study was motivated by a perception that the process of price quotation in design projects has not been adequately addressed in the academic literature. To address this process, 13 design specialists were interviewed and indicated four dimensions that structure the process. These dimensions were evaluated through a survey consisting of a 60-item questionnaire, testing 13 hypotheses with the aim of evaluating the correlation between the dimensions and the processes for estimating time and developing quotes on design projects. The survey received 427 responses and validated all 13 hypotheses, suggesting correlations between the dimensions observed, time estimation and price quotation on design projects. This study shows that the effectiveness of time estimation for the development of design activities may be increased by taking into account the correlations found among the process and the four dimensions of Knowledge, Execution, Design Method, and Planning and Control. Finally, it is observed that price quotation on design projects will be more effective to the extent that the time needed to execute the activities is more accurately estimated.

## 6 Limitations and future work

This article presents a view of design professionals focused on a small group of 13 specialists, who agreed on a set of elements that they considered relevant to ensuring robustness in the processes of estimating time and quoting prices on design projects. However, this set of elements might be different if a different group of professionals were consulted during the interview process. Although the dimensions listed are described in the literature as relevant to the process of product development, the processes of time estimation and price quotation may have been cited because of the similarity of the activities performed by the specialists who participated in the interviews, most of whom are involved in product design. A suggestion for future studies is that these dimensions be researched more broadly, for example, by using a quantitative study with open-ended questions.

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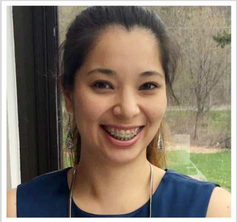

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